A REVIEW ON IoT PROTOCOLS FOR LONG DISTANCE AND LOW POWER

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***Abstract*: The evolution of IoT network is basically the effect of requirement of a system that is having better capabilities compared to existing ones. One main feature of the system that we need to satisfy is long range and low power. The protocols IEEE 802.15.4, 6LoWPAN, IPv6 and CoAP are used for achieving low rate, low power, large address space and reducing the data space respectively. In this paper we discuss other protocols which are intended mainly for providing long distance transmission with the less amount of power consumption. It mainly says about LoRa (Long Range protocol), IEEE 802.22 and weightless.**

Keywords: 6LoWPAN, CoAP, IPv6, LoRa, Weightless

I. INTRODUCTION

Internet of Things is an information network, which can connect any physical objects through internet. These objects can include mainly sensors, RFIDs, actuators etc. and it provide intelligent communication among them. Since we can connect a large number of entities IoT has got a wide variety of applications. By nearby future around 50 to 100 billion devices will be connected with the internet and then the potential ability of the network to support a large amount of data will also be emerged. IoT can be defined using different architectures since the number no. of devices it can accommodate is very large. But in general the IoT architecture is designed and maintained based on various protocols such as 6LoWPAN, IPv6, CoAP, IEEE 802.15.4 TCP, UDP etc. These protocols operations are distributed to various layers.

IEEE 802.15.4 is used to provide physical and media access control in the networks such as Low Rate Wireless Personal Area Networks (LR-WPAN). The basic structure of IEEE 802.15.4 network is capable to support transmission of around 10m with a data rate of 250kbps [1]. 6LoWPAN refers to IPv6 over Low power Wireless Personal Area Networks, which define encapsulation and header compression over IPv6 to improve processing capabilities. 6LoWPAN operates in network and data link layers whereas IPv6 capabilities are limited to network layer only. IPv6 when compared to IPv4 provide larger address space to improve technical benefits like route aggregation, multicast addressing etc. Another important protocol is CoAP (Constrained Application Protocol) that is designed for Machine to Machine (M2M) communication. CoAP integrates low power sensors, switches and valves, which are to be controlled and supervised remotely. UDP (User Datagram Protocol) is also referred as an IoT protocol since it highly support internet protocol suite. UDP is sometimes an alternative to TCP, which is used to establish connections over the applications of internet.

The ultimate aim of all these protocols are to establish an efficient connection between the different network elements and to make them communicate when they are placed at some specified distance. There are new protocols and standards for satisfying these requirements. We have a new protocol called LoRa (Long Range wireless protocol) which is developed to provide a transmission distance up to 15-20km. Another protocol is IEEE 802.22, which is a standard for wireless regional area networks (WRAN), operates in the white spaces of Television frequency spectrum. This offers coverage area much greater than that offered by other IEEE standards. A third type is “Weightless” that is the name of LPWAN (Low Power WAN) that provide data exchanging data between one base station and thousands of machines around it.

II. IOT: UNDERLYING PROTOCOLS

IoT network applications are supported by the different protocols defined over the various layers of the protocol stack. The main protocols that helped in the evolution of IoT networks are IEEE802.15.4, 6LoWPAN, IPv6, UDP and CoAP and are defined over physical to application layers respectively.

The basic structure of IEEE 802.15.4 network is capable to support transmission of around 10m with a data rate of 250kbps. This complete structure is developed and modified by the time of 2012 and then a new version called IEEE802.15.4e is evolved particularly for MAC layer security [2]. This protocol is defined for both Physical layer and MAC layer and Datalink layer which were previously controlled by IEEE802.11b and IEEE802.11g respectively [3]. The co-existence of IEEE802.15.4 and IEEE 802.11 b/g was analyzed Axel Sikora and Voicu F. Grozamadea made a study to analyze the Coexistence of IEEE802.15.4 with other Systems in the 2.4 GHz-ISM-Band [4]. IEEE 802.1.5.4 uses adaptive CCA approach, which is simpler but more robust, more responsive, and easier to be implemented at allowes cost [5].

6LoWPAN (IPv6 over Low power personal area networks) is the protocol that creates and maintains all the core internet standards and architecture work. the introduction of 6LoWPAN is done mainly because of the fact that IPv6 is not power efficient. Xin Ma and Wei Luo in [6] made a study 6LowPAN based on all other protocols developed before 6LowPAN. Due to the address space and openness of grand scale, 6LowPAN (IPv6 over Low-rate WPAN) working group was formally established by IETF to institute LR-WPAN standard based on IPv6, the purpose of this group was to introduce IPv6 into LR-WPAN which takes IEEE802. 6LowPAN working group works on the research of IPv6 protocol suite based on IEEE802.15.4 standard, and constructs self-organization 6LowPAN network with route protocol. 6LoWPAN is developed in many versions-TinyOS-2.x 6lowpancli, b6lowpan, BLIP

CoAP [7] is an application layer protocol, which is developed mainly for resource constrained internet devices, such as WSN nodes. Different entities of the network are addressed in a RESTful manner [8] and thus using CoAP IoT network offers a wide range of applications. In most of the applications RFID tags are used and when the tag is used as a data carrier, external applications could be interested not only in reading the tag memory, but also in writing new information.

III. PROTOCOLS FOR LONG DISTANCE

A. Long Range Communication Technology (LoRa)

LoRa is a Long range radio communication technology that utilizes low power level. The main advantage is that the demodulation is possible with a noise level less than 20dB. LoRa is mainly used to establish communication up to 15-20km by connecting millions nodes together. It is capable of eliminating interference and thus network efficiency is improved. LoRa supports modulation schemes such as OOK, FSK and a new type of modulation called as LoRa modulation. As the modulation scheme used change, packet format also changes.

Specifications

- Modulation: FSK, BASK (OOK) and LoRa modulation
- Possible frequencies: 109MHz, 433MHz, 866MHz, 915MHz
- Range: 15- 20km
- Data rate: 37.5 kbps for LoRa modulation
- Long battery life: in excess of ten years with millions of nodes

LoRa modulation supports FHSS modulation in case of transmission. The frequency hopping transmission and reception process starts at channel 0. The preamble and header are transmitted first on channel 0. At the beginning of each transmission the channel counter *FhssPresentChannel* (located in the register *RegHopChannel*) is incremented and the interrupt signal *FhssChangeChannel* is generated. The new frequency must then be programmed within the hopping period to ensure it is taken into account for the next hop.

The network architecture of LoRa is called LoRaWAN, which is for wireless battery operated things. This network makes use of star of star topology in which gate ways are transparent bridges. Gateways are connected with so many

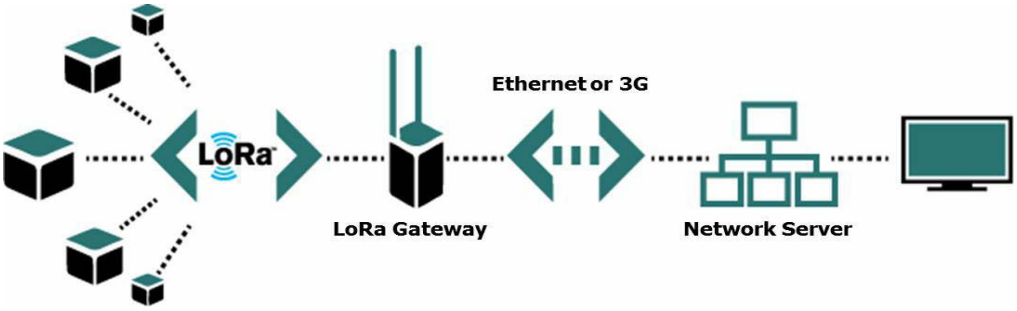

Fig 1. LoRa network architecture

nodes at one end and the network server at the other end. Gateway- n/w server connection is based on standard IP address. Each connection will have a different IP address. End point communication is bidirectional and it is at a rate 0.3 to 50kbps. End devices are made adaptive to data rate, thus network is power efficient.

B. IEEE 802.22

IEEE 802.22 is a standard for wireless regional area networks (WRAN), operates in the white spaces of Television frequency spectrum. The operating frequency is between 54 to 862 MHz especially with rural areas where the usage is comparatively lower. To achieve this cognitive radio is used to ensure that no undue interference is caused while using television spectrum. With operating data rates comparable to those offered by many DSL / ADSL services it can provide broadband connectivity using spectrum that is nominally allocated to other services without causing any undue interference. In this way IEEE 802.22 makes effective use of the available spectrum without the need for new allocations.

IEEE 802.22 offers coverage area much greater than that offered by other IEEE standards. For example IEEE 802.11 gives a range less than some 50 m only. But 802.22 can give a range up to 33km and sometimes the base station can reach up to 100km. The system is developed in such a way as to provide a capacity same as DSL services. The downlink speed is 1.5 Mbps and the uplink speed is around 384 kbps.

C. WEIGHTLESS

"Weightless" is the name of LPWAN (Low Power WAN) that provide data exchanging data between one base station and thousands of machines around it. There are 2 standards- Weightless-N and Weightless- W. First one works under sub 1 Ghz band that is mainly used for industrial, Scientific and Medical purposes (in ISM band). Weightless-N is designed to operate with Differential BPSK modulation scheme to transmit data using time Division Duplexing (TDD) with frequency hopping. In order to increase the range Weightless is able to support variable spreading factors and it accommodates low power devices with low data rates.

The key features of weightless are:

1. Global Open standard
2. Range 0-5km (indoor) and 0-10km (outdoor)
3. 10 Year Battery Life
4. $2 for module connectivity
5. Spectrum Flexibility

Compared to all these transmission protocols Sub GHz spectrum is capable to provide a large variety of applications. The two main modules that support this protocol are CC1200 and Si4468 and they are very commonly available. Both these chips are compliant to IEEE 802.15.4.

IV. CONCLUSION

The operation and maintenance of an IoT network is done with the help of different protocols like IEEE 802.15.4, 6LoWPAN, IPv6, CoAP etc. In order to improve the features of the existing system we integrate this protocol in different layers with other supporting protocols. In the perspective of increasing the range of the system with a low power consumption a new protocol had been

introduced, which is called LoRa (Long Range wireless protocol). This enables a transmission up to 15 to 20km with a data rate of 37.5 kbps.

LoRa network offers a wide variety of applications such as home automation, sensor applications, security systems etc. since it can accommodate millions of entities to a single node. Now a days more researches are being done over LoRa like range measurement, power reduction of IoT networks etc. In this paper the different features of LoRa network and its architecture were analysed and it is found that LoRa networks has got a variety of research scope on sensor applications also.

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